Menlo Park Notebook #85 [N-79-08-22]

This notebook covers the period August-November 1879. Most of the entries are by Francis Upton and Francis Jehl. There are also entries by Charles Batchelor and Samuel D. Mott. Included are notes, calculations, and drawings relating to experiments with metal filaments, carbon filaments, and vacuum pumps. The label on the front cover is marked "Tests of Spirals and pumps Aug. 23 '79" and "F R Upton." The book contains 282 numbered pages.

Blank pages not filmed: 82-83, 232-233, 246-249, 272, 275.

Missing page numbers: 265-266, 269-270, 273-274.

No 85
XE-327

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Presented by
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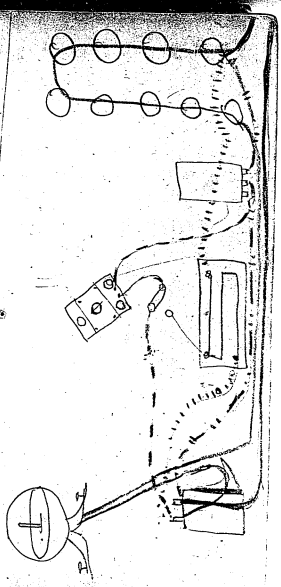
Sept, 1896.



Aug 22 1879

A spirals of .005 in. in diameter was wire wound closely on and sealed into a globe of glass. The wire ~~attached~~ by which the current was conducted through the glass was ~~made~~ platinum. The spirals was then placed in the bridge made as drawn on page 1

The glass around the Pt. wire ~~cracked~~ was enough to admit the vacuum

3.14	1.5
1.5	1.5

3.14	0.4969
1.5	0.1761
1.5	0.1761
44.3	1.6464
	2.4955

313 Reddish yellow

A spiral in a low vaccumm having a resistance of reddish yellow. Consumes with current of 1.5 Webers

313 foot lbs. required per minute

9

33.000 45,185
297 2.4733
2.0452
.0334
2.0118

1 H.P.
102 per H.P.

4.95 0.6946
3.65 9.4377
.1323
.0334
.1657

1.35 Webers
1.46 Webers

The experiment was continued after with the same no. of Webers the spiral rose to a bright yellow.

Around a resistance of 3.65 Ohm a deflection

$\frac{198}{200} \times 5.$

3.65 Ohm $\frac{.99}{4.95}$

.99
4.95
Comp 3.65
4.95
44.3

0.6946
9.4377
0.6946
1.6464

2.4733
.0334
2.5067

~~297~~ 322

8

322 2.5067
44.3 1.6464
1.8603
4301

2.7 cells of carbon

9

~~3.65~~

4.9.5

Amount 3.05 ~~Cold~~ Hot

Spiral ~~cold~~ hot 3.05 Ohms
cold 1.95 Ohms

Spiral 6 inches .007 in. 20 to 14.7

3.14
.007
.02198
6
.13188

13/100 in surface

13) 100 (7.6
91
90

8 Coupons an inch

Conducting wires 11 Ohms

Resumé Experiment No. 1

A spiral of wire made of 20% Pt. 9 n. alloy, .007 in. diameter and six inches long was sealed into a glass bulb.

The resistance of the spiral cold was 1.95 Ohms

just red to black	3.105 − 11 =	2.94
reddish yellow	3.14 − 11 =	3.01
bright yellow	3.65 − 11 =	3.54
whitish yellow	3.78 − 11 =	3.67

Remarks The current was passed through the two galv. but it was found that the measurements were not to be relied upon as the induction coil was too near the gal.

2 1.198
.199
5
4.95 0.6946
44.3 1.6464
4.95 6.6946
Comp 3.54 9.4510
1.08 .0334
1.08 .0334
2.5534

4.5185
2.5534
.9651

92
.13
276
92
11.96

356

Assuming the area of the bridge containing the large wire the high resistance galvanometer was placed and the deflection from compared with that from five cells of standard Daniells.

In the case measured

$\left(\frac{1.98}{200} \times 5\right)^2 \times 3.54 \times 443 =$

the no. of ft. lbs. of energy consumed 356 per minute or $\frac{1}{92}$ of a horse power that is 92 spirals having each .13 in. radiating surface could be kept at a bright yellow by one horse power. or 11.96 inches of radiating surface

~~Where the~~ This result was obtained in a vacuum good enough so that the phosphorescent light made its way into the bulb from the iron terminals of the gauging tube

When the air was let into the spiral was bully red and after the glass had cooled it was black.

32) 5.0 (.156
32
180
160
200

.156 1. 1931
.471 1.6730
2.8661

.073 1339

1/13

314
15
1570
314
.4710

Aug. 24. 1879

Spiral No. 2

A spiral wound very closely and kept in a vacuum over night. (without heating) The wire .007 in. in diam six inches long covered with Corundum. The spiral was placed thus spiral .15 in diam

3/32 long

13 to an inch

The vacuum was good enough to stop a half inch spark. When the current passed the sparks again appeared and the spiral was dull red.

200 | .85

.425

5

2.125 .3273

-1.08 .0334

.3607

comp 2.94 9.5317

log 44.3 1.6464

1.5388

.3607

3½ 1.8995

79 ft. lbs

This shows the air escaping from the Pt. after the vacuum became perfect again the spiral was brightened.

$\frac{85}{200}$ X 5 Daniells over

3.05

11

2.94 ohms

79 ft. lbs.

A carbon cell put on this spirals and nearly the same value obtained

1125
.7625
5
3.125 .4949
1.08 .0334
.5283
.5283
comp 3.19 9.4962
44.3 1.6464
2.1992

158 ft. lbs

after an hour
brought up to reddish yellow

$\frac{125}{200} \times 5$ over $\frac{330}{3.19}$ $\frac{11}{}$ Ohms

158 ft. lbs.

White

$\frac{263}{200} \times 5$ over $\frac{382}{3.71}$ $\frac{11}{}$ Ohms

1.315
5
6.575 .8179
1.08 .0334
.8513
.8513
comp 3.71 9.
44.3 1.6464

.8513
.8513
9.4306
1.6464
2.7796

602 ft. lbs.

4.15 × 404 = 6,81 × .6021 = .01160

2.9989 / 160 = 9.0149

1035 ft lbs

602 ft. lbs required to bring the spiral to incandescence

330 / 55

About a candle, with less

35.8 / 200 × 5

4.15 Lamps
11
4.04

2 (35.8)
1.79 — .2529
1.08 — .0334
.2863
.2863
comp 4.15 — 9.3820
44.3 — 1.6464
1.6010
25 — 1.3979
2.9989 per candle

Correction 1035 / 1036 ft lbs.

33 candles per H.P.

224

Deflection on magnet 18° 30'

1.04
1.04
864
1.04
1.16 LY

8.625 .9357
8.625 .9357
1.116 .0668
Comp. 3.74 9.4271
44.3 1.6464
3.0117

1027

2

In this spiral with the same current in the air gave much less light

In open air no change in the resistance

345/200 X 5

1725/5

3.85
11
3.74

8.625 .9332
8.625 .9332
1.116 .0666
Comp. 3.85 9.4145
44.3 1.6464
2.9939

1027 ft. lbs.

about 1/4 the light

824

Astral

27

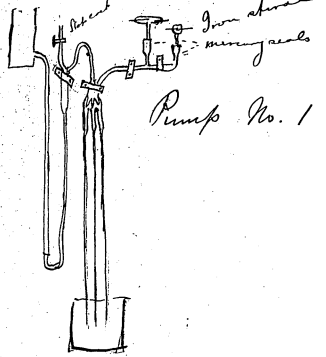
A steel ^ye of your what
A steel ^ was afterwards
brought to as to give what
was estimated as eight
candles by means of a tallow
dono measurement. Four
hours taken in bringing it
to white heat ——. This steel
taken to Saratoga.

Sept. 8, 1879. 29

The ~~induction~~ large induction coil was brought in order. The condenser was crossed and so that it had to be removed. On putting on the whole of a W. U. condenser 1.6 M.F. ~~there~~ a spark 3/4 in long only could be obtained.

Thinking the trouble might be in the coil we ~~examined~~ ~~it~~ ~~and found a break in it~~ cut off the covering and found all good. On putting back the wires a good spark was obtained with less condenser. 3 inches spark with six plating cells.

The three fall pump arranged thus



Pump No. 1

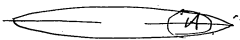
A .015 in. iron wire, was
fastened to
and a .020 in. Pt. wire and
sealed into a glass bulb
Difficulties met with.

Vacuum broke the cracked
piece of dirt in one of the
small jets preventing the Hg
from flowing out from
it so that as the other two
exhausted the air could enter
through the tube which had
little Hg. in it. The dirt
washed partly away and
heating the tube very hot
done enough away to the
sufficient Hg. fell to seal the
tube.

About 11-30 a good vacuum obtained. The tapping of Hg into the mercury seals seemed to help very much. A piece of dirt got into the middle tube and stopped its working.

Phenomena noticed. When at a blue stage the color relays could be made to appear on heating. The lower part containing Hg. was strongly heated so that the pumps was well filled with Hg. vapor. The aluminum electrode became bright yellow in the blue light with some green phosphorescence. At one time the yellow electrode could be made to change places by heating in the tube. It would jump over and

then dance as if uncertain where to stay after the flame was taken away.

B  A

A a blue light. Next and B grows smaller. Red end A larger.

Large coil started without any connection with induction terminals. Blue phosphorescence seen faintly. One of the terminals connected and the whole tube filled. Both terminals connected phosphorescence small, but electrodes yellow.

Sept. 9, 1879. 39

Iron spirals .015 in. wire

11-55 a.m.

½ Weber 6°

12-10 m. 12°

1 Weber the current had been taken off and put on suddenly several times increasing it in strength gradually.

12-55 21°

1-35 P.M. 26° red

1-50 P.M. 27° 30′ yellow

red in the middle of the outside seemed cold. The spirals came up extremely slowly.

2-05 yellow red

2-20 stopped

2-35 Started 28°

using the Faradic machine

2-45 29° 30' yellow

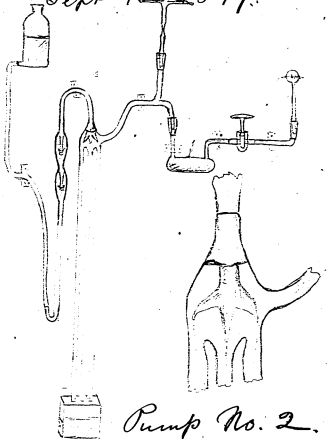
3 P.M 31°

3-25 P.M 35° Globe darkened

The chimal was then brought to a white, and the globe was found covered with a very dense deposit, and bright metallic lustre with fern like spots in it. It was extremely opaque. Dr. Haight tested it and found iron.

In trying to take the piece of glass out of the pump it was wholly broken. Bishop began to put the new pumps together. He worked all night and in the morning the tools were ready

Sept 10 1879.



Pump No. 2.

Sept 10 1879

Commenced 12-30 PM
The three tubes working well, joints sealed with Hg. Sulphuric acid in the Sprengel tube.

Fault

Should be

At 7-30 P.M. a vacuum was obtained good enough to stop the shock from the small coil.

The vacuum was lost in carrying the pump. Most trouble was met with in starting as the Hg did not flow from one of the drops. It was needful to allow one of the tubes to remain open so that no vacuum could be procured. That tube was sealed by placing a tube with Hg at the bottom, which was allowed to remain until the Hg fell from all three of the tubes.

10 P. M. Pump working well globe on it from lamps, all connected. Lamp a small double spiral regular model.

11. P. M. Blue evening stretching back ½ inch

12 midnight the pump broke. The rubber tube had swollen very much larger and the weight of

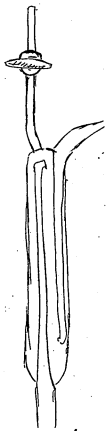
the Hg in bake the pump ~~jistabration~~ at the top of the ~~fountain~~ ~~on~~ upper air catcher.

Sept. 11 1879.

In the morning The pump was fixed again tried to get a vacuum but did not succeed Purged the Hg again & tried it again. commenced at about half past twelve. did not get any good results during the afternoon. the Hg would collect & fill up the fall tubes the Hg could not get through. That portion

of the pump where the
cloth covering was
which seem to be
covered with the oxide
and other impurities
at about four o'clock
the vacuum was very
poor, exhausted but
a little more to come

worked on it until
about twelve o'clock
but did not get
a vacuum. ~~at twelve~~
~~o'clock~~.



New Chamber

Sept 12 1879

The pumps was fixed in the morning, a new chamber was put in instead of the old one
new one old one
which gave very good results, we commenced at half past ten velocity a lamp made by Mr Bastian covered with (1/4)" of wick, made of Aluminium and Dextrine, and trimmed in two layers one time. got a vacuum so that the 1/8 inch spark coil, would not give any light at one velocity one then put on the

large coil and got a kind of red illumination, a half an hour afterwards we got a white kind of light we put one cell of the chromic battery on the bobbin at about half past one o'clock, with two ohms resistance in the circuit. it turns black (bobbin) owning to the organic matter (Dextrine) which was mixed the the aluminum.

at about two o'clock we got a bright white light, one of the electrodes took a yellow light on it.

at two yelwest & put a half an ohm out of the circuit.

At two minutes past two Mr Bachlor cutt out an other half an ohm. At twenty minutes of three Mr Bachlor put out an half an ohm. This make one cell carbon on the lamp and half an ohm at ten minutes to three we put two cell on with two ohms resistance, it just heated it up to a very dark red. There was a little change in the light, the yellow was fainter and a very light green spot.

was observed mean the yellow. At 3·20 pm we made Resistance ½ ohm less. This it was:—

			Remarks
1½ pm.	1 cell	2 ohm res.	Blackness spoil.
2 pm	1	1½ "	
2·10	1	1 "	
2·40	1	½ "	
2·50	2	2 "	very dark red
3·20	2	1½ "	Darkness but little brighter

{Vacuum has not altered during last hour} {owing to gas coming out of spool}

3.35	— 2 —	1 ohm.	
4·	— 3 —	2 ohm – red –	
5·50	— 4 —	2 ohm yellow	
5·55	4 —	1 ohm "	white

Some visitors came in the afternoon (Mr Bankor + others) and the spool was brought up with seven cells then it burst, owing at the Time about 4 Candles.

At eight velocet P.M. we put the pumps again in operation, a new spool was put in $(1/8)^2$ of an inch. covered with Aluminoid & Dorlonine.

At quarter past nine we put one cell on the spool

~~9.15 P.M. 1 cell. Resistance.~~

9.15 P.M.	1 cell	3 ohms Res	Remarks. Blackened it
9.45 ...	1 ..	2 ...	
10.10	1 ..	1	
10.15.	2 ..	1	
10.30	2 ...	0	cross. showed red only.
11 ...	3	2	the spool began to get red! Dull
11.20	3.	1	Red, goes down + up owning to the cross
12	cross pressure kept from going any further the spool away		

64

65

Put in a new spool at about eleven oclock + commenced a vacuum stop the pump at dinner sealed it at the bottom with Hg commenced 3/4 of an hour afterward again, vacuum no good. stopped pump,

~~Commenced again at four oclock~~ got a pretty good vacuum at 6 oclock,

7 1/2 V 2 cells 3 ohms Removed Right Rod
8 " 1 " " 2 " Rod in the middle cord on the ends

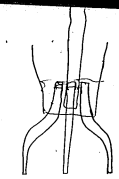
Mr Edison ~~bought~~ put on cleos after this until it busted (7 cells.)

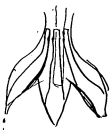
Sept 14 1879 67

Commenced in the morning on the tube of the pump put one of those pure rubber tubes in the large rubber tube, Did not not get it working, change it again, got it working. Commenced on the vacuum at 12.15 lost it on Taking off a stop cock at 12.45 Commenced on vacuum at 12.50. Got a good vacuum after this.

7.45	2 cells	3 others very little	Removed
8.	2	Redrin the middle one with the	

Mr Edison added cell after this until it bursted (7 cells)





A new spool was put in at twenty minutes past nine, and we commenced the vacuum. At twenty minutes past ten the pump bursted (being heated to much on of the fall tubes broke.

Sept. 15 1869.

Pump repaired in the forenoon. Put in operation at one p.m. perfect vacuum at half past two p.m. Commencing of heating the lamp about at half past three.

At half past four o'clock the spool was busted by the large inductivis coil one wire being on the gauge and the other free

This was the third one 71
buried in this way
At five fourty we commenced
again on a vacumm, the
lamp on which the spool was
was creack it was covered
over by sealing wax.
it was no good we cut the
lamp out, and got a vacumm
at about ten oclock
Sept 16
We commenced at halff past
eleven to put the pump in
operation with a new spool
in. Did not get her going

Sept 17 1879

Got a good Oneal Batchelor vacuum at about one o'clock A.M. The spool was brought up one of the leading wires gave away, so we stop.

Commenced again at half past twelve, with a new spool.

A.M. At			Remarks
2.	1 Cell	3 Ohms	
2.15	1 "	2 "	
2.45	1 "	1 "	
3.10	1 "	0 "	
3.25	2 "	3 "	Little Red
3:40	2 "	2 "	more Red
4	2 "	1 "	Red
4.10	3 "	3	"
4:35	3 "	2	
4.50	3 "	1	

P.M. 5.	3.	clear		Rain 7.30
5.30	4	3		bright red
5.50	4	2		white

Thursday 23 Sept. 1897

Put in a new spirals at 6.P.M.

	cells	R	
6.	1	2 1/2	
6.50	1	2.4	
7	1	2.3	
7.20	1	2.2.	
7.40	1	2.1	
7.50	1	2.1	
8	1	2.	
8.10	1	1.5	
8.30	1	1	
8.40	1	.5	Little Red
9.	2	1.	Red

Kept it at this point till half past one (1) o'clock.

Commenced again at eight o'clock in the morning (Sept 24)

	cells	R	
8.	2	1	Red
10.40	2	.6	
10.50	2	.5	
11.	2	.4	
11.10	2	.3	
11.20	3	.6	White
11.30	3	.5	
11.40	3	.3	
11.50	3	.0	

Sunday Sept 23 1877

Shot Catcher

Commenced at about half past five, got a vacuum at about six put a current on the spiral at 6½

	cell	Deg
6	1	4°
6.20	1	6°
6 40	1	6½

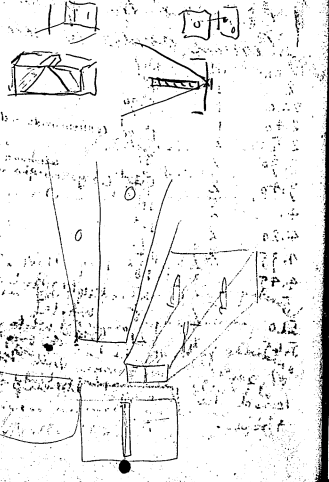
broke the lamp as Mr Edison put 7 cell on it and busted it.

Commenced again at eight vacuum at about nine put current on it at 9.20

	cell	Deg	
9.20	1	4°	
9.35	1	6	
9.50	1	7½	
10.00	1	8	Dull Red
10.20		10½	
10.35		12½	Red
10.50		14°	Bright Red
11.20		18	

11.40	3.	19		
11.55	3	21	bright. White	
12.20	3	24		
12.45	4	26½		
1.10	4	29		
1.50	4	36	forced on the account of Hg timing in the leads.	
2.10				

84



85

Sept 25 1879

Glass covered wall
Cabinet Ox in 0006 P. Ir. 207 [illegible] all
[illegible] Expanded Type apparatus (1).
[illegible] Erbium oxide (2) Aluminum

Bath Temp.	Time	Cell	Ref.	
	2	1	4°	
	2.20	1	5.30'	
	2.40	1		
	2.50	2	6.30'	Cerium oxide w dull Red
	3.30	2	9.	Aluminum dull RED
	3.45	2	9.45	C.O. Yellow-red
	4.	2	11.	
	4.20	2	13.	
	4.35	2	14.	
	4.45	3	16	
	5.20	3	18	Wh. red
	5.45	3	21	bright white Dull

[illegible] gentleman came [illegible] Edison
and he brought [illegible]
[illegible]

The L+D. Coating ... powder a ... find that ... is browned ... to ... to L+D oxide

Mercury in globe ... blocks ... glass ... glass clear ... Hg =

Lime melts perfectly to a ... green ... phosphorescent ... glass ... Cerium ... also most of ... the ... as ... as lime ... & far better than Cerium ... aluminum

Exhausted two spirals again at 7.30. Covered one (1) LANTHANIUM & Didymium oxides .006. another with Cerium oxide .006

	CELL		
7.35	1	7.30	
8.50	1	5.	
9.	1	6.	Gbl. t.
9.15	1	7.	
9.30	1	8.	Dull RED st.
9.45	1	9.	Red
9.55	2	12.	Red

Mr Edison brought them up then the cerium oxide busted the Lanthanium & Didymium ... but ... (7.4.) ... the words of the lamp ... that of the 7 ... went off ...

Yours truly
Jno T. ...

with an Aluminum [illegible]
Cerium the Cerium [illegible]
incandescent white the [illegible]
Lime was only yellow [illegible]
although the Aluminum [illegible]
brilliant was brilliant [illegible]
than the Cerium —

With Lanthanum & Didymium
[illegible] one of Lime. The former
was brilliant incandescent
white the Lime was yellow
[illegible]

[illegible] Lime [illegible]

September 26 1877

Charles Reed two lamp at one time. One was covered with Lime .006 and the other was Lanthanum and Didymium .006
He got in the globes.

Time	Batteries	Dep	Remarks
9.30	1	3.30	
9.50	1	7.	
10.5	1	5.	
10.20	2	7.	Dep Lan. giving red
10.35	2	7.	Dep the is yellow Red while the lime is pretty Red
10.45	2	9.	
10.55	2	11.	brought them up Then

Put two Limes one on this .006

12.30	Batteries	Dep	
1.	1	5.	
1.15	1	5.	
1.25	1	7.5	
1.37	1	8	
1.45	1	10.	Yellow Red
2.	2	11.	Red
2.15	2	12	
2.40	2	14	

over

90

The of the thine I was headed up more than the other, or there
perhaps due to having less
coaling than the other, I
brought them up very high
a date of good light

91

time	dec		
2.55	4	16°	bright Red
3	4	17	
4	4	18	
4.30	5	20	White
5	6	21.30	Bright White

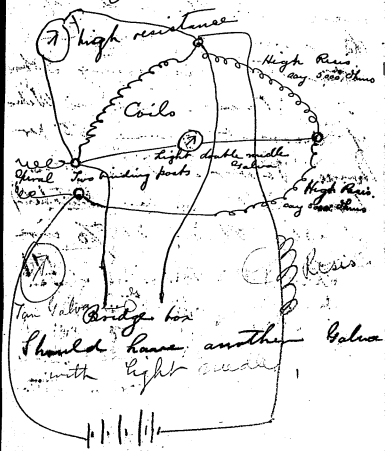
Commenced again on the Spitzes at 7.30 this morning

7.30	1	4	
7.45	1	6	
8.15	1½	8	Dull Red
8.30	2	9	
9	2	11½	Bright Red
9.20	3	12°	Red
9.45	3	13°	
10	3	15°	
10.30	3	16°	White
10.45	4	19½	Magnificent
10.55	5	20°	
11.05	6	22	

Mr. Edison claims eight candles from this Spiral. George to read at the end of the week a rough estimate, assuming 2.2 Ohms as resistance and 12 Webers of Current gave 6.5 per Horse Power. This was from 1/2 inches (Bitchits) of .006 [illegible] 20 [illegible] There [illegible] millions in [illegible]

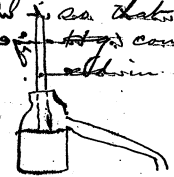
Oct. 1. 1879.

Shall put the Spirals in bridge



Should have another Galvo with light

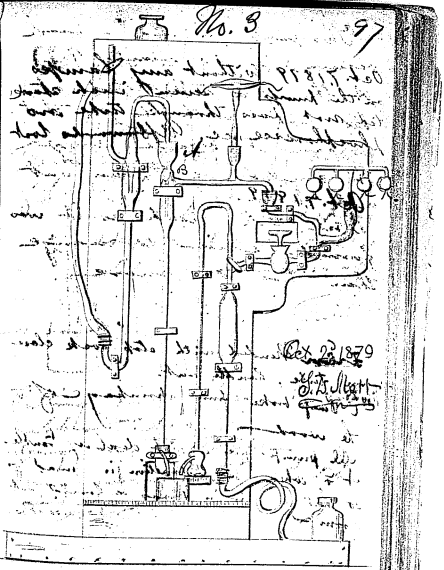
Changes in ~~pump~~ and two made
~~Glass~~ ~~tubing~~ with Greiner
~~Rubber~~ ~~Stopper~~
Cu. tube for absorbing Hg.
Mercury bottles at bottom
of all tubes this
so that the escaping
~~Hg~~ could be collected
~~again~~ ~~in~~ ~~the~~ ~~vessel~~



Putting more rubber in waste
rubber tubes.
Using one fall tube
Doing away with cloth
strainer.

96 This pump pumped in a second
recorded 20 minutes
A. The fall tube
that point with Hg
in case it became stopped
it could be
air channel.
B: The pump broke here.
given.

No. 3 97



98

Oct. 7, 1879 Without any Sprengel's on the pump a seven inch spark did not pass through tube, no phosphorescence. Afterwards tried

Oct. 7, 1879

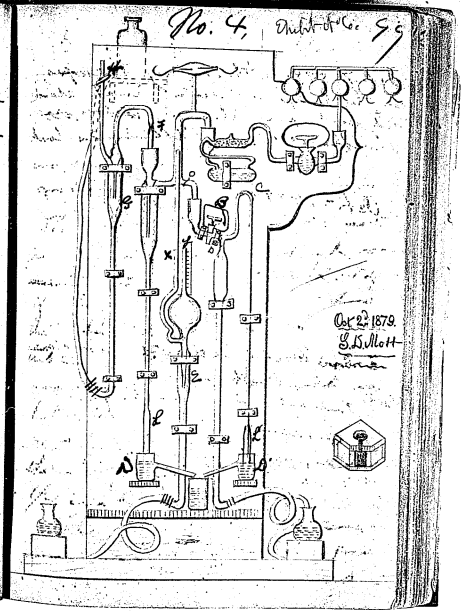
C. The pump broken here, Francis thought that there was a vacuum in the four tubes and put the stop. too quickly up.

D The pump taken off broken here Mended with stop cock close on tube, handle out.

Nov 29 Pump broke from shrinkage of the wood.

All pumps give a great deal of trouble at F where a contraction is made so that the air in B may be forced out from it

No. 4, Duplex Hg. 99



B This stop-cock placed too far from the main reservoir so that the tube near it caught air. This could be worked out by letting the Hg overlap work up and down.

The MacLeod should not be used until a high vacuum has been attained. For if this has not been done the Hg sticks in the side tube. Last evening a vacuum was obtained so that the spark jumped five inches outside of the tube rather than across 1/8 inch in vacuum.

The changes in vacuum were extremely rapid, from green to a small spark

in a few seconds and then in a few minutes to stopping the large spark. The finely divided copper and sulphuric acid may have had a strong influence on this.

7. The tube contracted here so that a pressure can be obtained by G to drive the air out through the stop cock H.

The enlargement of the tubes at d d' is a mistake as a bubble of air collects here and is drawn up into the pump. Making stop cock D with tube to left inclined upwards may be a mistake as the Hg collects -- take out cock and stop the hole.

Pure black rubber tube placed inside of white rubber to prevent boiling Hg.

Tried Iron Spiral

3-15 F .007 in. diameter

1 cell of Calland battery through 450hms outside

3-45 2.5 Ohm

4-15 1. Ohm

The vacuum becoming constantly better as shown by the MacLeod Gauge

4-40 MacLeod Gauge

105 — 59

5.00 P.M

105 54*

1 cell on Spiral dull red air probably

Coming out as the gauge showed ~~fresh~~

105	45	5-15
108	33	5-40
108	41	5-55
108	50	6-05

The pump was 7-30 PM
taken off at six and
the battery put through
the spiral alone, until at 7-30
~~exactly~~ as was no red-
ness could be seen.
The gauge then ~~drew~~
showed so great a change
that the surface of Hg was
in the globe below the 0
when that in the tube
was at 108

Mr. Edison proposes measureing the amount of air given off from a spiral by means of Mac Cleod guage. The exaustion should be once made and the pump stopped, then if the capacity of the guage and the pump be known the air given off may be calculated

110

Spiral covered with rust
time.

At 6 PM.			Rain
	6 15	1	4
	6 30	1	3½
1	6 50	1	3
1	7.15	1	2.5
	7.30	1	2
	7.50	1	1.5
		1	1. Bright Red Letter Day
Wagner 5 miles			9 over again it with one ecce,
	9	2	1.5
22 mile			
24	9.12	2	.8
	9.20	2	0
	9 30	3	.2
	9 50	4	.7
	10	4	.2 Rain at this Time

256.

1 - 6

4

16

44

64

64

704

352,

176 -
6

058

3½) 1584 (454 5
142
18
17½
1

3½) 45½ (1 :
35
44

33
6
198.

7) 451 (64
42
31
28 - 3

64
4
256

	cell	ohms
1.30	1	3
1.50	1	2.5
2	1	2
2.10	1	1.5
2.20	1	1
2.30	1	.5

If lamp has three ohms and remainder

Spiral covered with
~~from~~ zinc acetate
from the acetate
probably about one ohm

	cell	
1-30	1	3
1-5-0	1	2.5
2	1	2
2-10	1	1.5
2-20	1	1
2-30	1	.5
3	0	0

The MacLeod showed
the level at bottom of
tube from upper lead funnel.

mm Hg	cell	R
3.15	2	1.7
3.10	2	1.2
3.40	2	2
3.50	2	0

Goes off at about 2 candle (daylight judged) leaves wire perfectly true and very bright. showing that the Zn did not attack it at all.
Tinted the glass so that we got a reflection of the ~~shield~~.
Wire ~~exposed~~ 4 cells ~~heated~~

Two spirals
One Tatanic oxide, and the other quice from the oxide + water
Vague showed before. The current was on just at the beginning
at 5:20 1 cell 1 ohm
5 40 1 0
Vague showed at 5:50 20 mm
6. 2. 1.5
6.40 2 0.

showed just at the beginning
being due to the arc and
the spiral R.

T.	3 cells	I	Red
7.10	3	0	
7.15	4	.5	white heat
7.30	4	.0	

Gr. arc at 7.0 13 mm from 10 m.
= 95 mm.

δ . 4

The Zr. was bright
in the inside of the spiral
while the Titan. remained
well insulated
The Zr. oxide volat-
ized but did not
melt.

The titanium brought up and gave ~~gr~~ five or six candles.

When the Jn. gave a bright white light the Titanium gave only a red. It may be that the latter does not give such good results.

3.5
3.5
18.5
10.5
12.3

Gas light 12 candles small jar Photometer made of paper and shot.

Leading wire of Titanium spiral melted 5 cells over .2 resistance. Glass not coated. Good Spiral.

MacCleod Gauge 125

Wt 102.512
100.154
2.358

Wt. in tube so that the top of meniscus came to mark

107.722
28.646

Wt. of Hg in figure 5 times 79.076

Taken 79.076
5

In double necked vessel 395.380

126

2.964
.176
3.140

127

12 less 148.700
13.105
135.595

63.213 wt Mg.
63.037
.176 mg to find mols
63.037
61.073
2.964

Oct. 8, 1879.

At this date the trouble is to get an insulation from the platinum wire. all the common oxides melt and volatilize at a far lower temperature than the Pt. after the process. Again many of the oxides become conductors at the temperature of incandescent Pt. All the known oxides are to be tried in various vacuums for it is thought that some one may answer the purpose or a hint be given as to a method of fusing the oxides, as Pt. has been prepared.

130

Oct. 5, 1879

131

Pump No. 4 was broken and is slightly changed and repaired.

The stop cock B is now close to the ~~to~~ main tube so that no air is held in side tubes. The to vessels D, D' were made longer so that the Hg. would not splatter over.

In starting the pump the Geissler worked well, but the Sprengel pump required a long time. The cleaned dumps, perhaps pumps moist from air in pumps it.

Spiral insulated with Silica.

In trying the pump it was found very difficult to get a vacuum. After several hours the air dried was heated so as to drive out the air in it and a good vacuum was obtained in

an hour. The Cu. [illegible] the SP4 were removed Oct. 10. The Cu. [illegible] [illegible] [illegible]

Probably [illegible] reading [illegible] Rowland says that he may not have fastened the Pt. well to the small tube in which it was fused. The glass around the wire was opaque with small cracks.

The lamps leak though no crack can be seen in them. The glass may be different.

Carbon stick

Put in arm of bridge and heated resistance decreased

Stick 8 inches, long .060 in diam

5°. 5 Ohms

Same stick heated by the current decreased its resistance. Red heat oxidized and increased.

Mr. Edison thinks that pure carbon would increase its resistance on heating. That the cause of ordinary carbon decreasing is that the fine particles make better contact with each other.

Trying to mould stick of .010 in diameter and to make them into filaments

136

137

Oct. 11 1879

Pumps, dumps dry. Three
3755 ohms 205-42 = 63 mm
4-15 105-54 = 61 m

Field Shunt in bridge
Warm 2.5 Ohms
Yellow 3 Ohms
3-55 Ohms

Oct. 13. 1879

Steller and still good light from both poles. N_2 in. Pumped the tumbler on and allowed to run very fast. Good vacuum to stop small sparks in an hour.

106 − 45 = 61 min.

~~Mt. Lambo Alton~~

.95 − .07 = .88 measured with dividers from bridge top

The air shut in the MacLeod gauge locked at E Pump No 4 page 99 at a high vacuum except into the pump and destroyed the vacuum this tube should not be closed until a good exhaustion has been obtained.

Spiral covered with Black X

.95 - .07 = .88 Ohms in Spiral measured cold from Bridge Box

Vacuum 1.05 - 5 2 0 = 5 3 1 1/2

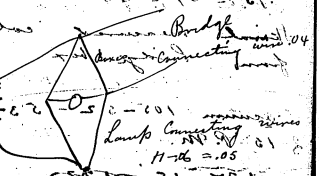
3-15 P.M.

1.28 - .11 = 1.17 Ohms

1.15 Ohms

In fridge .05 Ohms to be deducted when the E.M.F. is calculated

.01 to be added when the resistance of Spiral is measured



1.32 + .01 = 1.33

Spiral 1.33 Ohms

Spiral 1.31 Ohms measured current through it with conductors

1.31 − .09 = 1.22 without conductors

1.21 Ohms measured direct.

Take off .09 Ohm from resistance for conducting wire.

Take off .04 Ohm for E. M. F. for conducting wires

No perceptable deflection 5-40

5-45 P. M.

1.50 Ohms − .09 = 1.41 Ohms

Deflection

1.1 ~~Daniells~~ Volts

1.50 − .04 = 1.46 Ohms

$$\frac{1.1 \times 1.1}{1.46} \times 44.3$$

1.21	0.0828	
44.3	1.6467	
comp 1.46	9.8356	
	1.5648	
36.7		Black
33.000		4.5185
		1.5648
		3.9537

146

147

Red dark on sides

1.65 ohms

9

1.56 ohms

$$\frac{1.3 \times 1.3}{1.56} \times 443 = 481$$

687 per H.P.

Red 8 1509 gn.

all red

1.80

.04

1.76

$$\frac{1.8 \times 1.8}{1.76} \times 443 = 404$$

404 per H.P.

.3222
.3222
1.6464
9.7392
2.0307

4.5185
2.0307
2.4878

3979
3979
1.6464
9.7212
2.1654

4.5185
2.1654
2.3531

2.25 H.P.

Yellow red supporting wires red

1.78 Ohms

2.1 X 2.1 / 1.82 X 44.3

.307 for H.P

Yellow

2.5 X 2.5 / 44.3 = 1.4

H.P.

.51585
1.6464
9.16925
2.3759

4.51585
2.37597
2.14226

5798
5798
1.6464
9.16536

4.51585
2.45596
2.05989

.6435
.6435
1.6464
9.16478
2.5812

4.51585
2.58112
1.93473

3.3 X 3.3
2.03
44.3
1.99
33% for H.P.

3.8 X 3.8
2.22
44.3
2.27 - 5 Ohms
114 per H.P.

4.4 X 4.4
2.28
44.3
2.30 - 5
86.6 H.P.

3

49.
44.3
2.25

4.5185
3.8797
.8388

7482
7482
19.64464
9 6 1 6 2
2.75900

3.3979
.6464
9.63544
3.6791

4.5185
2.7590
1.7595

About a candle

50 X 50 = 2500
232 X .6467

2.37 - 5 = 2.32

69 per H.P.

247 - 5 = 242

8.6 X 5.6 = 44.3
2.42

238

58 per H.P.

Results of Oct. 13. 04

Rivals covered with silica so that there was a thick coating completely hiding the form of the wires. Dead White fluffy.

Commenced at 5 P.M very weak currents

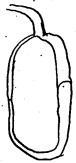
No. per H. P.	Color	Resistance
	Cold	1.22
6 P.M. 687	Red dark on edges	1.56
8-15 404	All red	1.71
8-40 307	Yellow red slipping wires not	1.78
225	Yellow	1.86
139		1.99
114		2.18
86		2.21
9-20 69	1 Candle about	2.28
58	Fair light 2 candles about	2.38

The stirrup broke off at 13.7 the leading wires. The stirrup was bright and seemed under the microscope to be covered with a bright glaze.

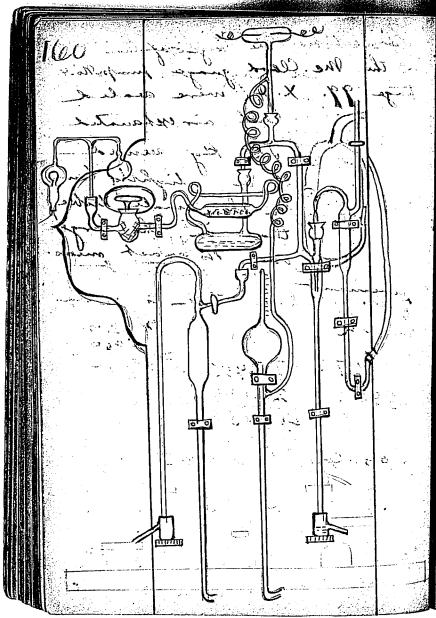
The stirrup ~~was~~ burnt with the same battery as was one for the last when after a few minutes of rest it was put on suddenly.

Oct 4, 1879

Two tubes the size of those 154 in the Mc. Cleod gauge pump No. 4 page 99. X.Y. were sealed and air exhausted.



The Hg seemed to be slightly lower in the small tube than in the large one. No exact measurement.



160

MacLeod Gauge 161

See page 125 - 127

Wt in bulb 395.380
in tube 3.140
Total 398.520

3.14 0.4968
395.38. 2.5970
3.8938

.0073 The constant of the whole tube to lower mark.

395.380
2.964
398.344

.176 · 7.2455
398.344 2.6003
4.6452

.00044 Constant

162

163

$$\frac{760}{10000000} = .000760$$

$$= .00076$$

Let x = pressure in guage
p = height Hg. in tube
V = volume bulb
v = " " tube

$$(V+v)x = (p+x)pv$$

$$Vx = pv$$

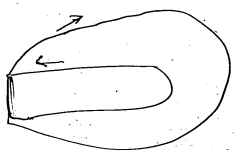
$$x = \frac{v}{V}p$$

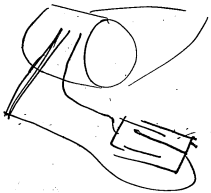
$x = .00076$ $\quad p = \frac{V}{v}x$

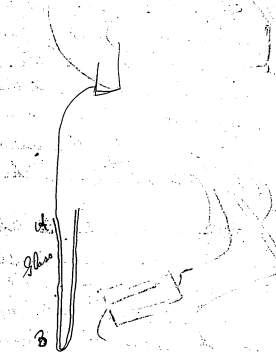
$\frac{v}{V} = .00044$ $\quad p = \frac{x}{\frac{v}{V}}$

$$p = \frac{.00076}{.00044} = 1.72 \text{ mm.}$$

Pump No. 5 Oct. 17, 1879. 165







In starting not enough Hg in the MacCleod gauge and air bubbled in carrying Hg into pump. Some fell into the Hg H_2SO_4. The pump was opened too quickly and Cu was also carried into the H_2SO_4 where it united with the Hg and now the mixture was slowly attacked by the acid giving off bubbles, spoiling the vacuum.

A long glass tube was used to take the place of the rubber one. Bubbles from half way from the vessel to the bottom A. B. Bubbles seemed to get in at A when there was a vacuum when the Sprengel was shut off. The tube changed for rubber so that the joint at B should be under pres-

ounce and the air in the tube A.B forced out by means the thumb and finger

Oct. 19, 1879. A stick of carbon brought up in a vacuum to 40 candles (2ay). Mr. B— trying to make a shiral of carbon. Screw in the pump. Snap broke. Tryed to make carbon shirals

Oct. 21. Stick of carbon about .020 and ¼ inch long gave cold 4 Ohms incandescent 2.3 Ohms. very good light Rt. minutes Smelled.

22
22
44
44
484
44
1936
1936
21296
5851.84
1703

24
24
106
48
556 2.7679
144 1.6466
29 8.5375
2.9518

895

Oct. 22, 1879.

Carbon spirals and threads

Trying to make a lamp of a carbonized thread. 100 Ohms can be made from a inch of .010 inch thread.

A ~~thread~~ thread with 45 Ohms resistance when cold was brought up in a high vacuum to 4 ~~ohms~~ Ohms about. It remained constant for two or three hours and then the resistance seemed to concentrate in one spot. Resistance cold 800 Ohms.

172

170

Thread lamp filam
1.5 Volts 3.05
3.24
around 6.26

26.5 Volts around lamp

comp 1.5	9.8213 81
26.5	1.43 32
6.26	.7966
	2.0536

113 Ohms in lamp

26.5	1.4332
26.5	1.4332
44.3	1.6461
comp 113	7.9463
	2.4588

288 4.5185
2.4588
2.0597

114 per Horse power

174

13 1.1139
1.1139
2.2278

14 1.1461
1.1461
2.2922

1.2041
1.2041
2.4082

17 1.2304
1.2304
2.4608

175

Thread

31.3 Volts on lamp

1.4 Volts

amp 1.4	9.8538
6.26	.7966
31.3	1.4935
	2.1459

140 Ohms after ½ hour

	1.4955
	1.4955
	1.6464
	7.8540
	2.4914

310 ft lbs

	4.5185
	2.4914
	2.0271

106 per H.P.

light equals about ½ candle

Lamp 1 hour
on 3-45

Thread carbonized and lamp black. Very brilliant light all the evening on Broke.

Paper plain No. 3

Thread with lamp-black very fine light on several hours giving out two or three candles and an hour and a half giving a gas jet. No Change. two candles loading wires brought.

None of these carbon spirals
blacken the glass

Lamp thread five
seconds. 196 Candles
after bringing up the resistance cold Becomes 265
the 275 – 285
Giving about three candles
resistance 187 Burning
required 82.5 Volts
1610 ft. lbs. Nov. 5, 1879.
20.4 per H.P.

Nov. 3, 1879. Lamp A. L.

Six coils thread .02 Franklin

Resistance cold

85.9 Ohms

Cherry red R = 53.86 Ohms

ft lbs 1251

Bright red R = 50.61 Ohms

ft lbs 2467

White Bright R = 49.76 Ohms

ft lbs 2702

Brilliant White R = 47.6 Ohms

3.348 ft lbs

See Book 28 page 180

Nov. 5 1879 163

Lamp No. 18 Six strands No. 200 thread

Resistance cold 75 Ohms

Brought up suddenly and air exhausted several times. About 4 or 5 vacuum each time Pump No 4

77 Ohms Cold

White one hour 78.7 Ohms cold

79.7

Very last few minutes 84.7 Ohms

Platinum sphere carbon thread was attached to the Pt. wires too large. It contained about .00061 Cu. inches of material estimated Vol. If this could contain and hold 800 times its bulk of air it would contain 1.22 cu inches

~~Expt. B 44~~

To test whether the carbon is reformed. Take the times it takes the lamp to burn alone when the lamp being cut off.

7 minute 31

~~Expt~~ at 6.47 my temp. was 63 — 107. I had my cork turned off, and hereon my lamp put out. I put my hand all of the ~~gauge~~ gauge all ready. At 6.51 I cut out the lamp. ~~Expt~~ Expt. my stop cock and set up my ~~gauge~~ gauge. My ~~gauge~~ gauge showed 55 — 109. I ~~had~~ had ~~Expt~~ a second time letting it have some time when the ~~gauge~~ gauge showed 55 — 109. After letting this ~~gauge~~ gauge down for 9 m. I put it up again, and it showed 54 — 104. I then put on my lamp at 7.10 turn of the stop cock and ~~had~~ had again ~~gauge~~ gauge showed 53 — 108

I got a good vacuum at 7.30 — 62 — 107
Sealed it again and at 7.40 gauge showed 62
4. Shown the lamp to Police gentlemen at 8.30
Left it on for 24 hours
Measured its R at 9.01 was 95 ohms at 9.3
Measured 95 ohms Nov 6 1879
Sealed it again and at morning gauges 50 — 107
Then heated lamp, and Kept on pumping
The mercury tap which the glass tube attached to pump leaked. Then lamp after bringing up 20
[illegible]

Lamp No 25 when cold measured 1050 ohms. I then adjusted My battery so that it heated the carbon not red, And kept the current on and my gauge showed a good vacuum about 46—108. I then added 3 more cells, and it heated it up to cherry red, and about ten minutes afterwards the gauge was 58–108. I then added 2 more cells, the last 2 cells added made it a little more red, gauge showed 68—107. I now added another cell this one being a chromic cell, the others being Fuller. I measured its R was 415 ohms. gauge showed in a little while 63 — 105

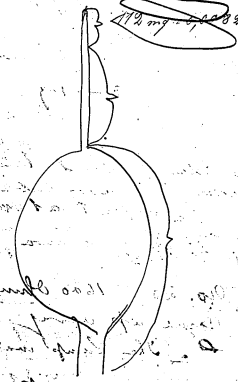
I then added another cell gauge showed 63—107
I now added 2 more cells gauge showed 32—106
Measured R was 420 ohms
I then added another cell. In about ten minutes I added another cell. I noticed an arc on the spiral. It broke where the arc was, gauge 5—105

I commenced again in the evening on the other spiral No 24 which was heated once before. The gauge showed 58—106. I put the current on it and heated it. (all batteries were on) the gauge showed 4—105 I left the gauge a little afterwards, and it was below reading.

measured to R, gave 2 Megohms Resistance. Measured it on the gauge about half an hour afterwards and it was 3—10⁵. The vacuum did not increase much, and we began to blow itself about ten o'clock and worked it half up, so that at nearly midnight it gave away.

Tread Exp. 20 1600 Ohms old. Came up very irregularly. The lamp was placed in a circuit Around the shunt A. After bringing up the shunt A was opened and the lamp was melted. Perhaps coincidence perhaps discharge from magneto.

192



No. 1 in Pipe 193

No. 30 cold 2.35 Ohms

No. 2 X pipe

~~No 30~~ 3.07 Ohms

No 29

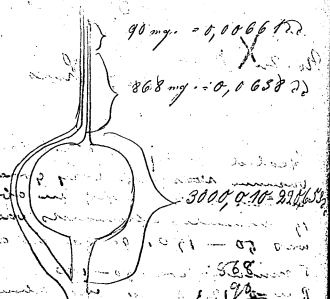
Heated No 29 to a white heat vacuum was not very good wheel not read; in about 15 minutes afterwards vacuum was 50 — 150; gauge in about 5 minutes was 50 — 100

R was 12½ ohms. in about 5 minutes gauge was 50 — 71

gauge was 50 — 69 R. now 120 ohms gauge was, when ace chrome was on, no. R being in circuit, was 50 — 90; gauge showed

50 — 60

194



195

3.000010 6.4771
958 2.9814
3.4957

3130 times as much in bulb as in tube

$\frac{60}{76a} = \frac{3}{38} = \frac{1}{12.66}$ 3)38 / 1266

3130
12.6
18780
6260
3130
39438.

1.000000 6.
4.5958
1.4042
25.37

30 mm = 25 M.
6 mm 60 25 M
3 mm
3/5 mm

1900 No. 29 Jan jet about 1.4 E.

5°2 : 145 : 24 : X 66.9 Ohms

2.1614
1.3802
8.2840
1.8256

26/24 1 Weber

6 3/4
3/18
2

72.5 1.8603
72.5 1.8603
comp. 8.1744
1.6464
3.5414

3480 4.5415
3.5410
.9771

9.4 per H, D

No. 29 gave an apo
about the commutators until finished.
1/4 inch sandpaper
No go.
got a good Vacuum then
I put on the machine tested
my vacuum, which was 60-60
Brought it up suddenly
and made test as follows

7.3R : X :: 120° : 158° = about 55 ohms

Volts consumed 79
79
711
553
6241
44
24964
24964
55 | 274604
4992 fills about 6 3/4 Pts.

about 3 gas jets
1.4

198 No 37 white when before heating 9000 R.
37 before heating 470, after heating it to a white heat R was 300.
about an hour incandescent
R = 265
about half an hour incandescent
R = 310
"Busted" on pump

No. 37 Burnt on the pump from an arc

No. 31 cold 2000 Ohms 99.
Piece of paper.
This did not become even red.
No. 38 cold 3000
Thread. Did not become red.
Both these lamps at almost the same moment burnt up forming a bad arc melting the conducting wire. Perhaps they suddenly carbonized and reduced their resistance freeing an amount of air which allowed the arc to strike F.R.L.

200

3 p cold 18000 Ohms

brought up 155 Ohms

Good lamp showed two or three jets without change Mr Lowrey & Wright saw it. Sealed off and shown in middle of room small arc at limit of contact.

1 P.M.

Nov. 14 lamp on 2 hours

9 A.M. 140 ohms Stuck @ 3,000 ohms

4 P.M. 140 ohms Stuck @ 6000 " "

5 A.M. 140 No arc.

2/39 19.5 Volts on resistance 21.8 Ohms.

1142/71 Volts on lamp

19.5 : 71 :: 21.8 :

Two measurements candle power 10.5 to 17

No. 21 cold Mounted

260

No. 1 w. 75 Ohms

Burstein. Two lamps placed in multiple and the connection to one of them broken and the other lamp burnt with a bright flash.

71 1.8513
21.8 1.3385
Amp 19.5 8.7100
1.8998
79.4 Ohms

1.8513
1.8513
1.6464
8.1002
3.4492

2810

4.5185
3.4492
1.0693

11.8 per H.P.

202

No 41.

When cold, the measured 10000 ohms. It is about to of inch br. and 3 inches long. Ignition spark passed through it and air driven out. At first no spark afterwards a fine light vacuum glow.

A vacuum of $\frac{4}{2.3}$ M

= 1.6 M obtained Nov. 13

Nov. 15, 1879

Francis says that the resistance of the lamp yesterday was 147 Ohms and constant.

This morning on three hours after considerable moving and jarring

134+ Ohms !

134+ Ohms !!!!!!!

11-12-30

1 to 4 P.M

4 hours
5
4.1/2
3
12 1/2
3 1/2
16

Monday Nov. 17

Rest A 8-30 A.M

Resistance ~~vacuum tube~~

147 Ohms momentary contact

137.7 Ohms current 8 cells in bridge

Lamp off 12 M

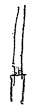
204

146 ohms tapping with key

141.5 ohms on all the time

this last was made 130 ohms by tapping showing that the one which could be seen was a break.

Broke off at the clamps 21 ohms



W42

Spiral No 15

201

R when cold 157 ohms, after warming 0—60 it was heated to a red its R was 114.7. V

Are at clamps.

A = 43 Nov 19 1879
B = 44

Two Lamps A + B. A when cold 1700. B when cold 1900
Put a vacuum gauge was 0 — 90 B ~~was~~ was heated with the current and then measured 128 ohms.

A put in series with B and became first dark red then with a large part bluish then bright red. While B did not come up at all
430 Ohms
The Yellow red for seven minutes
133 Ohms
Both Lamps in series almost exactly alike at the dull red

208

10-45 pm In multiple arc

Yellow

12 M. The vacuum became very fine and soon does not seem to change just

When the spirals were cut off the vacuum made quite rapidly

Spirals on cold vacuum ~~1 P.M.~~ soon

2 P.M. Spirals put on yellow bright

Exhausted the air out of 43 at the evening. after being exhausted and cold measured 115 ohms. 44 was also exhausted and measured 112½ ohms

44 was to are opening and would be very badly be connecting wire but did not effect the exhaustion.

43

209

Nov 20 1879

two lamps No 45 & 46.

No 45 when were 380 ohms

" 46 " " 410 ohms

No. 46 showed a small area. sealed off, small break near the clamps. but in stand

45 Vacuum remained quite fine

Measured 145 Ohms cold

7 1/2 Lamps sealed off

with ~~100 ohms~~ 120 ohms hot

Nov. 20

No. 47.

after Carbonizing 430 Ohms

3-45 P.M.

Moderate vacuum put on for a short time

Yellow # 112.5

vacuum very poor

Nov. 21

Again heated

107. Ohms

No. 48

after Carbonizing 430 Ohms

Red 285 Ohms

Yellow 225 "

Higher yellow 207

~~vacuum very poor~~

~~48~~ Nov 21 Yellow

2.01 9

Bad photo

Very Bright 203

212

43 100 Volts on lamps
14 Volts on resistance

4158
14.5

100
100
10000

49 125 Ohms
Bad are N.G.

Nov 22 1898

50.

214

Nov 24. 1879

55. when cold before heating
2700 ohms.

56 When cold before heating
about 4000 ohms.

56 heated beside for a little
while, went down to 150 ohms.

55 Went down to 186.

heated an hour or more

168 Ohms

215

56 Cold before heating
4000 Ohms

heated for a short time
1786 Ohms

91 J.
heated an hour or more.
160 Ohms

216

57

When cold before Eating
R was 255 ohms
Heated it for a moment
and it went down to 115 ohms

Mrs 58, 59, 60, 61 Left on the counter 217
moment 3 P.M.
When cold before heating
about 17,000 ohms R.
Dull red good
1000 ohms
Very even yellow 187 ohms cold
after supper I measured it
it was 1.6

218

59

When cold it measured
2500 ohms R. This was before
heating
Fair vacuum
Dull red good
1570 Ohms old

Poor vacuum very even
yellow not bright
164 ohms

Measured after copper 147 ohms

60

When cold it measured
1900 ohms R This was before
heating
Excellent vacuum
Comes up to yellow
155 Ohms old

Good vacuum
Bright yellow 142 ohms old

One hour and a half
air leaked into pump

220

61

When cold before heating
measured 312 ohms R
First coming up moderate
vacuum irregular Brightened
245 ohms

Good minimum
Bright yellow 135 ohms

62

221

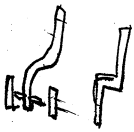
222

63 when cold it measured 430 ohms - This was before heating

64

When cold about 10000 This was before heating. Put the current on and [illegible] it burst

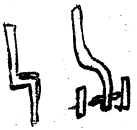
22



224

65

When cool before heating its resistance about 190 ohms
The current was put on for a moment and it was reduce to 132 ohms.
~~Current was 132 ohms~~
Current making ~~them~~ it ~~this~~ about an hour bright yellow 122



225

66

when cool before heating its R was 190 ohms. It was then heated for a moment and its R was reduced to 132 ohms.
Current ~~has~~ ~~held~~ yellow about an hour
185 ohms

226

67.66 broken

227

228

70

When cold before heating the R was about 1900 ohms after heating a moment it was reduced to 168 ohms

71

229

When cold before heating 310 ohms. It was Then heated for a moment and it went down to 141 ohms.

Nov. 28, 138 ohms. marked

In cool room weighted 148 ohms

Copper dust in the bulb

360
120 Volts
120
144 00
44
576

5.80161
1.96579
3.83782

576
92 | 633600
6884

4.80851
3.83782
.68669

25 | 360 C.V.
25
110
100
10

M.C.
6.4
576
864
92.16

Ref page 236

72 When cold before heating 270 ohms. Heated for a moment resistance was reduced to 100 ohms. Measured afterwards, it had the current for a while and ... 114

73 When cold it measured about 220 ohms. when heated for a moment it was 177 ohms. after the current being on for a while it measured 185.

When weld before hunting
it measured 365
after hunting it was
reduced to 160 ohms
very rot 169 ohms

78 there in it was a knick.

Page 229 22 345 / 115 Volts

~~22~~ 115 ~~230~~ 2
166
50
44
6

6.4
4

22)345(15
22
125
110
15

15.6
6.4
6 2 4
9 3 6
99.84

15
115
575
115
115
13225
44

5819)3300000(5.6
29095
39050

529 80
52900
58 19.00

Book 9
5.4 per H.P of large flame gas the E.L. being ~~of~~ ~~the~~ ~~E.L.~~ ~~being~~

Yo when cold before heating it was 1100 ohms after heating and atmosphere it was reduced to 340

when I put the current suddenly it burned at one of the ends.

Cold unheated 8.00 Ohms

81. Bright red 920 Ohms

240

82

Short circuit. Before heating it was 4.00 ohms.
When heated for a moment was reduced to 3.00 when finished 2.50.

241

19 : 259 :: 6.4 : 128 Volts

259	2.4133
6.4	0.8061
19	8.7213
	1.9407

87.2 Ohms

19)259(

128	2.1072
128	2.1072
44.3	1.6464
.873	8.0593
	3.9201
	4.5185
	.5984

88.20

3.9

84 Before heating 2500 Ohms
Very bad spots and slightly
bent in first bringing
up after bringing up 204 Ohms

85

86 Before heating 400 ohms
after moderate heating 155 ohms
remarkably even at red heat

210

911

92 before hunting rop

93 700 before heating

94 Before heating 800 Ohms
Very even heat at red
Incandescent for a very
short time 205 Ohms

95 800 before heating. There is an arc on one of the pools.

No number marked X before heating 700 ohms

256

No Number, marked 1

About 700 before hearing

255

700

White spirit before hearing

630

218

101

before hearing 3.50

219

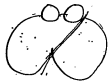
102

before hearing 4.20

141 before hunting 295
142 gi [illegible] 300
143 after hunt the first time 192

262

1



1 cum
2 work 4

1 x 2 = 2

2² x R = E

0/0

2/2 = 1

C = E/R = 10²⁰/2 4 5

20/2 = 10

C x R = E 3 x 2 = 10 E
11 x 2 = 20

C² x R = X = 25 x 2 = 50
50 x 2 = 100

E² * R² x R = X

100 ÷ 4 x 2 = 50

E² * R = 100 2 50

1 1st 1 2d = 1 work
2 1 = 2 4

2² x R = 4

24

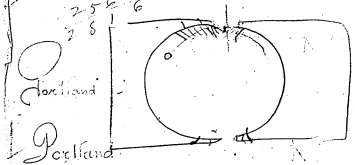
35,

Slots 700 foot

14
4
56

64
44
5 5 6

2 5 6 6
7 8 1



1.4
1.4
56
14
196

1.4
1.4

29 | 33000
16500
204

206

206
20
4120

205
20
4100

201
20
4020

202
20
4040

2668

Phonos

London.

90.

10.

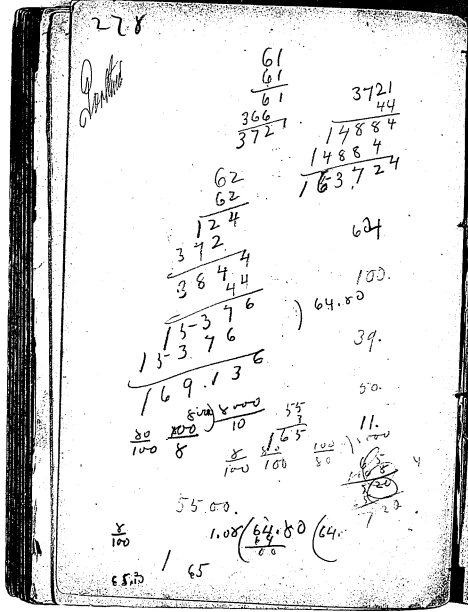
80
80
6400.

20
20
400

450
450
17,600.

8800,

4400,



2304

89100 2
78200

55

60
60
3600
44
144 00

48
48
3841
192 4
45 2 3

144 00
144 00 60
1 55 54

40
60 44

55
3

50
25 24
64 00
64 00
1700

45
45
2025
180
20.25
81 00
81 00
40 00

10
17 00

81 00
81 00
89100

4.

89.100.

1.08
21.60

1.08
21.60

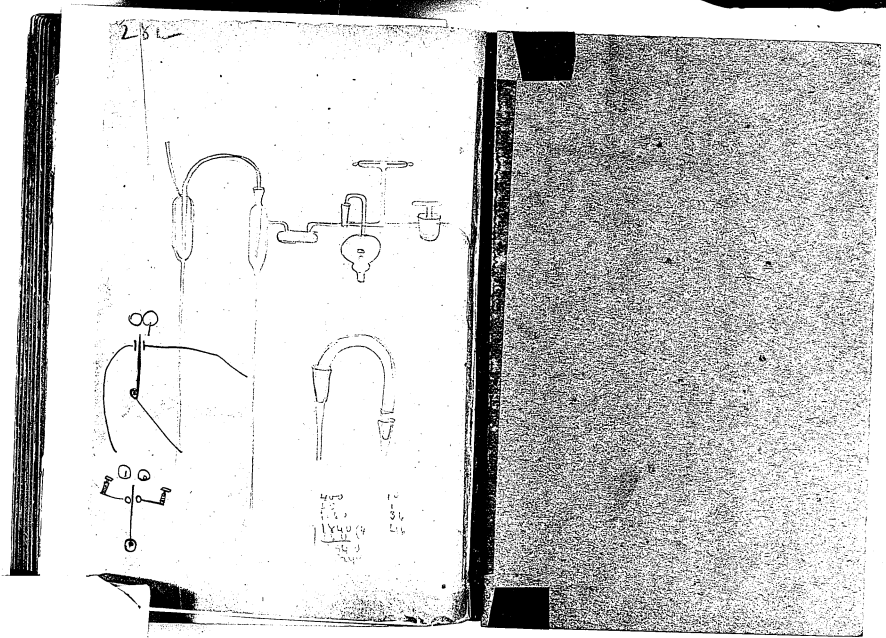
2 ohms 50 volts

~~200000~~
110 000 ft lbs -

3 : 1.08 ::

3 :
21.60 : X :: 3 : 1.08

21.60
3
64.80

21.60 : X :: 3 : 1.08
46

1.08 | 64.80. (60
0 000